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However, in our particular case, the patient had been admitted to the hospital 4 days earlier because of weakness and prerenal azotemia. She was on the same statin and diltiazem combination upon that admission. During that hospital stay, she had 3 negative troponin test results. It was only after discharge, when she started feeling symptoms of her cystitis, that she started taking the phenazopyridine. This prompted her return to the emergency department, at which time the elevated troponin level and methemoglobinemia were identified. We understand that a temporal relationship alone is insufficient to establish causality. However, these circumstances offer compelling evidence that the drug induced methemoglobinemia played, at least in part, a role in the development of the troponin leak.

The relationship between statins and elevated troponin level (which may be further enhanced by the concomitant presence of the calcium channel blocker) may be of more than academic interest to clinicians; the most recent American Heart Association guidelines [2] recommend prescribing statins to almost half the US population [3].

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References

- [1] Cannon RD, Wagner M, Jacoby JL. Troponin leak associated with drug-induced methemoglobinemia. *Am J Emerg Med* 2014.
- [2] Stone NJ, Robinson J, Lichtenstein AH, et al. ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol* 2013;2013.
- [3] Pencina MJ, Navar-Boggan AM, D'Agostino RB, et al. Application of new cholesterol guidelines to a population-based sample. *N Engl J Med* 2014;370(15):140319140040007.

A manikin model for study of wound-packing interventions to control out-of-hospital hemorrhage ☆☆☆★



To the Editor,

With hemorrhage being the primary cause of mortality on the battlefield [1–3], wound packing practice by US military medics in the wars since September 11, 2001, has changed from a conservative to an assertive approach. The foremost emphasis changed from preventing

contamination to controlling hemorrhage. As no specific hemostatic dressings were available at the start of the wars, after such dressings were fielded, medics changed their approach by packing wounds with more gauze earlier in casualty care and deeper into subfascial cavity wounds as a way to control hemorrhage. Although experienced medics and trainers favor an assertive approach, there is limited empirical evidence of improvements. In addition, with the development of various dressings with hemostatic properties [4–6], no systematic approach to trial wound packing techniques easily has been developed.

When a war ends and military medical care shifts toward peacetime duties and garrison work, skill sets in trauma care degrade as skill performance is less often. Furthermore, peacetime training reverts back toward everyday work such as sick call and away from future combat casualty care. The reversion tendency allows less training of new medics in combat casualty care than those who were trained during busy years of sustained combat; like nothing in peacetime, the present danger of combat during wartime focuses attention on hemorrhage control. A challenge for medics to be as well trained in peacetime in combat casualty care as during wartime is a recurring theme of military medicine.

Of the medical advances in prehospital combat casualty care during the current wars, we feel that the most important are regular tourniquets, junctional tourniquets, and wound packing because of their potential capacity to save numerous casualties from the most common cause of death on the battlefield—wound exsanguination.

To not backslide on these 3 skills, we continue scholarly work to refine them. We call these skills the “Big 3,” and we have published mostly on tourniquets. To stimulate development of best practices in wound packing, we now focus the present report on an introductory test method to increase awareness of knowledge gaps within the science of wound packing. The purpose of the present study is to introduce a laboratory model of hemorrhage with data comparing gauze wound packing and medical device use to better understand out of hospital hemorrhage control.

In an approved protocol, we used a manikin model designed for the capacity to train medics in techniques of gauze wound packing for hemorrhage control in trauma care. The manikin trainer (Combat Ready Clamp [CROc] Trainer Manikin; Operative Experience, Inc, North East, MD) had a gunshot wound of the right groin that bled water from the common femoral artery; the wound track went through the thigh posterior to anterior. We measured blood volume lost from bleeding, the application time, and hemorrhage control (yes/no). We had only 1 user who had never packed a wound prehospital and had never been trained in this task. We made 4 tests. The first test was that we used a type of gauze (QuikClot Combat Gauze; Z Medica, Wallingford, CT) alone in accordance with its instructions for use (IFU) except we used no overwrap for pressure; the overwrap is the fourth and final step of the gauze IFU. The second test was like the first, but we used the full IFU that included use of an overwrap (AirWrap, RevMedx, Wilsonville, OR). The third test was only the use of the overwrap and no gauze; this test included no inflation of the pneumatic bladder within the overwrap. The fourth test included the gauze, the overwrap, and the inflation of the overwrap. Each test had 4 replicates.

The results showed an apparent differential performance of the methods of hemorrhage control, but the test order indicated possible learning that may be a confounder. The fourth test performed better than the first 3 with respect to reduced blood loss (Fig. 1), which may mean that the fourth method is best or that the user learned with experience. Perhaps both are true. Application time also improved (Fig. 2), and the evaluation was sensitive enough to detect longer application times with additional steps in the wound wrapping process.

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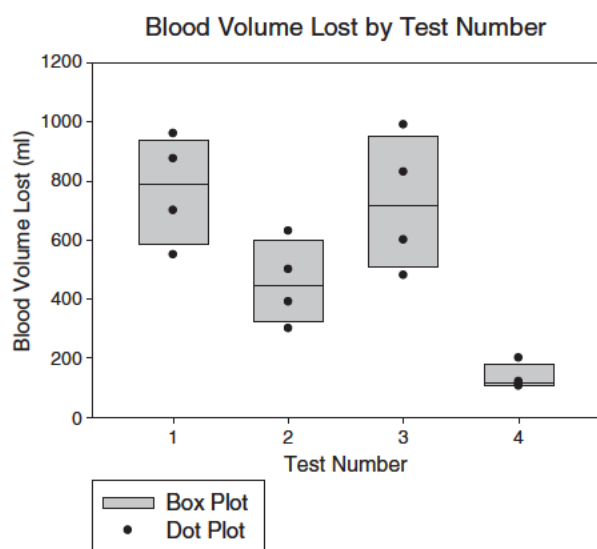


Fig. 1. Vertical dot plot of data points for blood volume lost by test numbers 1 through 4. Each test number had 4 replicates. The box plot shows the parameters of the data within the overlaid dot plot. The box top is the 75th percentile, the box bottom is the 25th percentile, and the black line in the box is the median.

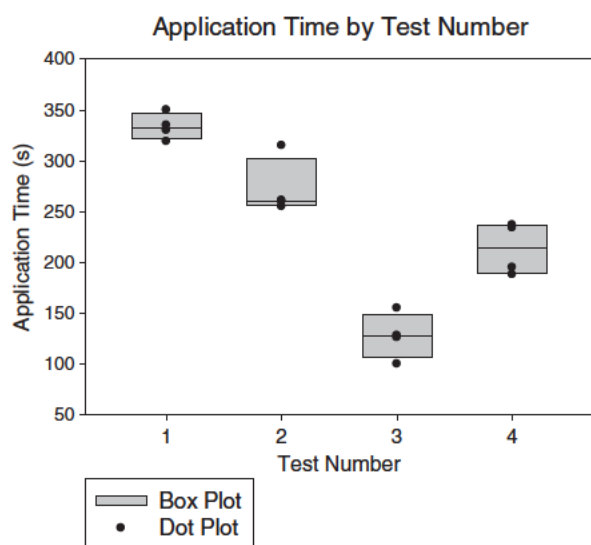


Fig. 2. Vertical dot plot of data points for application time by test numbers 1 through 4. Each test number had 4 replicates. The box plot shows the parameters of the data within the overlaid dot plot. The box top is the 75th percentile, the box bottom is the 25th percentile, and the black line in the box is the median.

There was no surprise that the gauze performed better as indicated by reduced blood loss (Fig. 1) when it was used fully in accordance with its IFU in that the second test performed better than the first. In addition, there was no surprise that the overwrap performed better when it was used fully in accordance with its intent in that the fourth test performed better than the third since the overwrap was designed to wrap over gauze.

The strength of this report is that it introduces a method of analyzing wound packing techniques that generated hypotheses for testing. Hypothesis driven experiments will follow this hypothesis generating report to check differential performance of techniques such as preliminarily studied here. The method permits learning curve

analysis to see how fast users can be in hemorrhage control; we have previously found that tourniquet use, for example, appears to take more than 30 tests before users flatten their learning curve [7]. Determining optimal care techniques and training regimens may help to improve clinical performance.

The limitation of the present report is its introductory design; the preliminary finding is only able to generate hypotheses. Future directions include analyses of techniques and learning curves.

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References

- [1] Eastridge BJ, Mabry RL, Seguin P, Cantrell J, Tops T, Uribe P, et al. Death on the battlefield (2001–2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg* 2012;73(6 Suppl 5):S431–7.
- [2] Eastridge BJ, Hardin M, Cantrell J, Oetjen-Gerdes L, Zubko T, Mallak C, et al. Died of wounds on the battlefield: causation and implications for improving combat casualty care. *J Trauma* 2011;71(1 Suppl):S4–8.
- [3] Blackburne LH, Baer DG, Eastridge BJ, Kheirabadi B, Bagley S, Kragh Jr JF, et al. Military medical revolution: prehospital combat casualty care. *J Trauma Acute Care Surg* 2012;73(6 Suppl 5):S372–7.
- [4] Kheirabadi BS, Arnaud F, McCarron R, Murdock AD, Hodge DL, Ritter B, et al. Development of a standard swine hemorrhage model for efficacy assessment of topical hemostatic agents. *J Trauma* 2011;71(1 Suppl):S139–46.
- [5] Kheirabadi B. Evaluation of topical hemostatic agents for combat wound treatment. *US Army Med Dep J* 2011;25–37.
- [6] Kheirabadi BS, Scherer MR, Estep JS, Dubick MA, Holcomb JB. Determination of efficacy of new hemostatic dressings in a model of extremity arterial hemorrhage in swine. *J Trauma* 2009;67(3):450–9 [discussion 459–60].
- [7] Clumppner BR, Polston RW, Kragh Jr JF, Westmoreland T, Harcke Jr HT, Jones JA, et al. Single versus double routing of the band in the Combat Application Tourniquet. *J Spec Oper Med* 2013;13(1):34–41.